Modeling Larval Connectivity for the Southern California Bight

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Presentation to the MLPA Master Plan Science Advisory Team
December 17, 2008 • Los Angeles, CA

QuickTime™ and a decompressor are needed to see this picture.

Why Model Connectivity?

- Knowledge of how larvae are transported from one site to any other on all time scales
- Need continuous descriptions of velocity on time scales from hours to decades
- Data sets are just getting to this point
- Models naturally integrate over all scales

HF Radar Current Observations

December 14, 2008

December 14, 2007

HF radar surface currents
0.5 to 6.5 km resolution
Coverage is now great

www.sccoos.org/data/hfrnet/

December 14, 2006

Talk Outline

- Circulation model (ROMS) configuration and its assessment against observations
- Estimation of potential & realized connectivity matrices
- Interpretation of connectivity patterns

Model Configuration

Regional Ocean Modeling System (ROMS) (www.myroms.org)

One-way nested grids (~20km → ~6.7km → 1km)

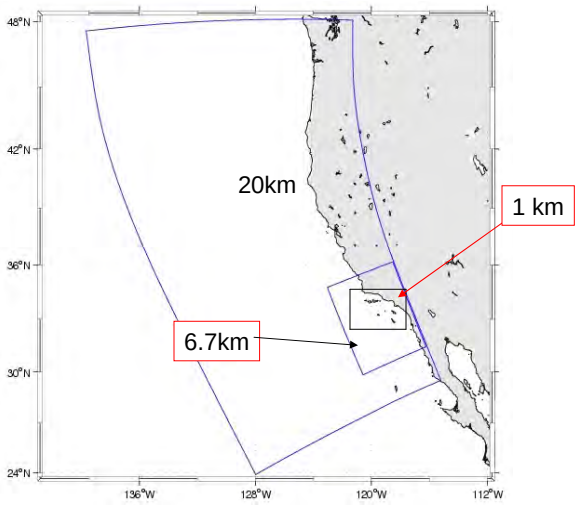
Surface Forcing from NARR Data (MM5 18km, 6km, 2 km)

Open Boundary Forcings (SODA, monthly updates)

Initialized with climatology

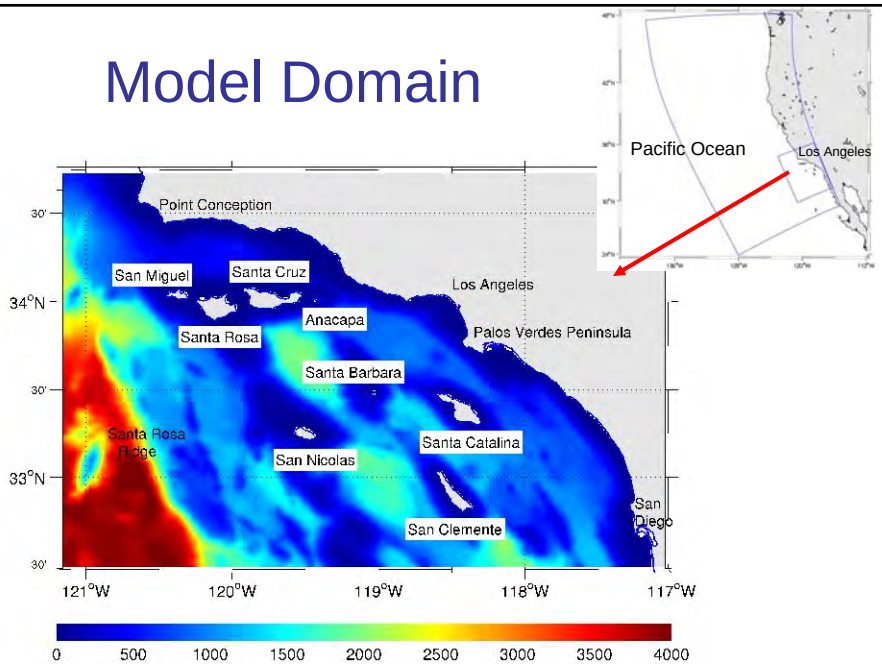
Integration from 1996 to 2003

Integration to present in progress



Dong & McWilliams CSR (2007)

Model Domain



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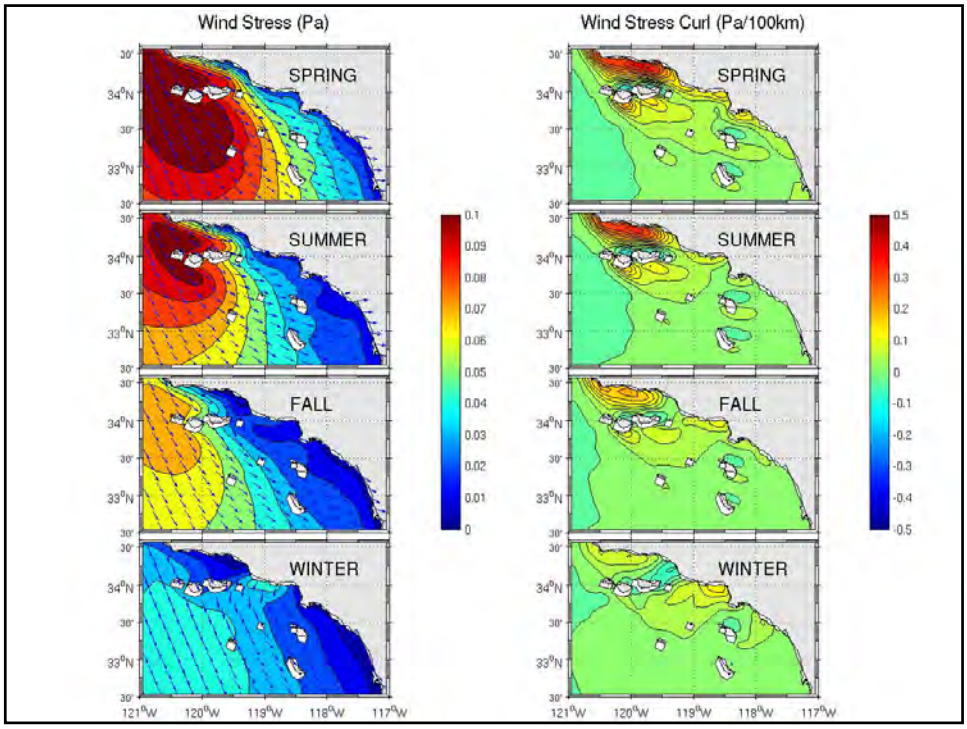

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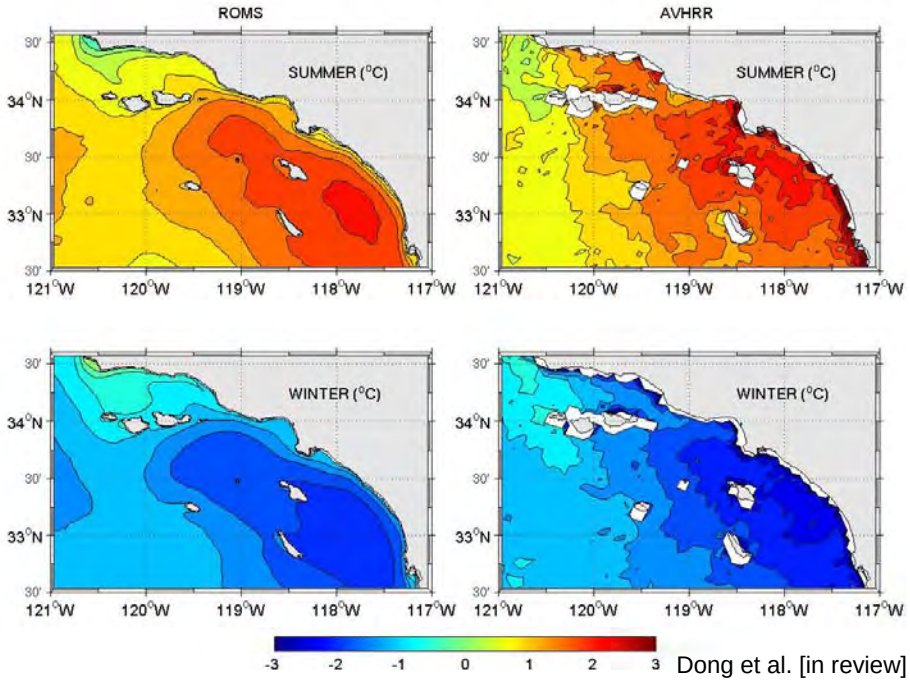


Dong et al. [in review]

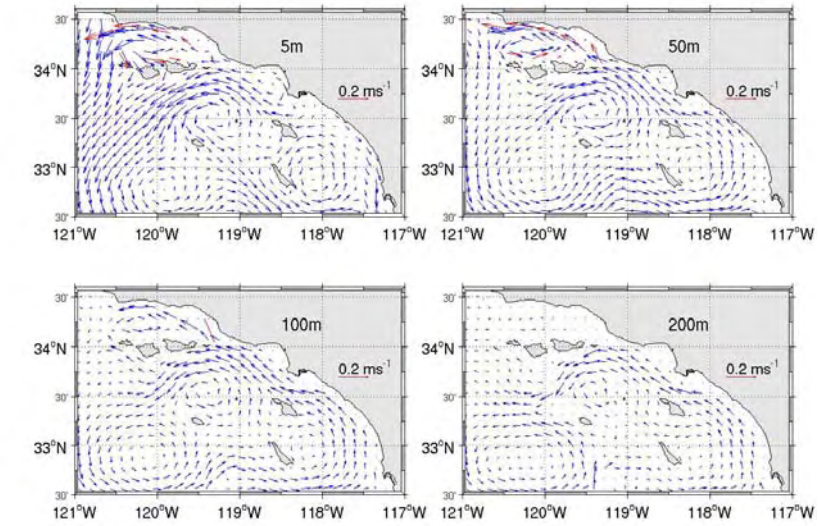


Figure 5: Eight-year mean currents (1996-2003) from ROMS at four water depths: 5 m (upper-left), 50 m (upper-right), 100 m (lower-left), 200 m (lower-right). The red vectors are the mean currents at the MMS current meter sites: SMIN,SMOF ROOF, ROOF, GOOF, ANMI, CAIN, GOIN, ROIN (clockwise starting from the northwestern site in the Channel) and BARK in Santa Monica Bay.

Dong et al. [in review]

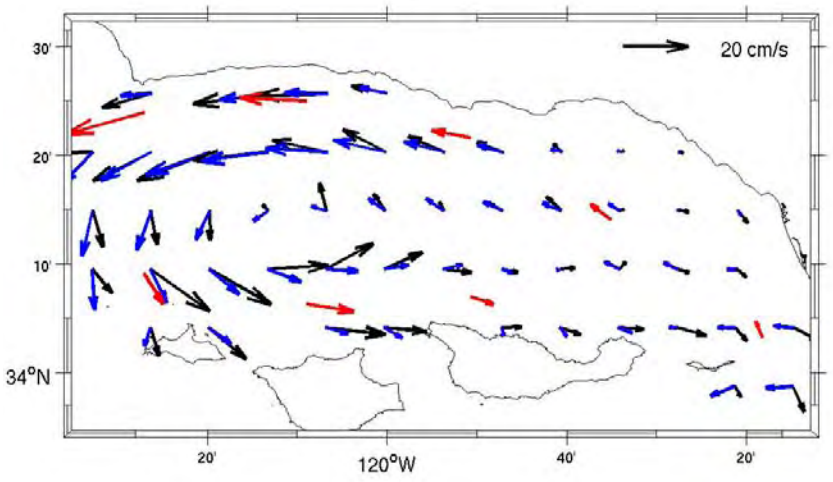
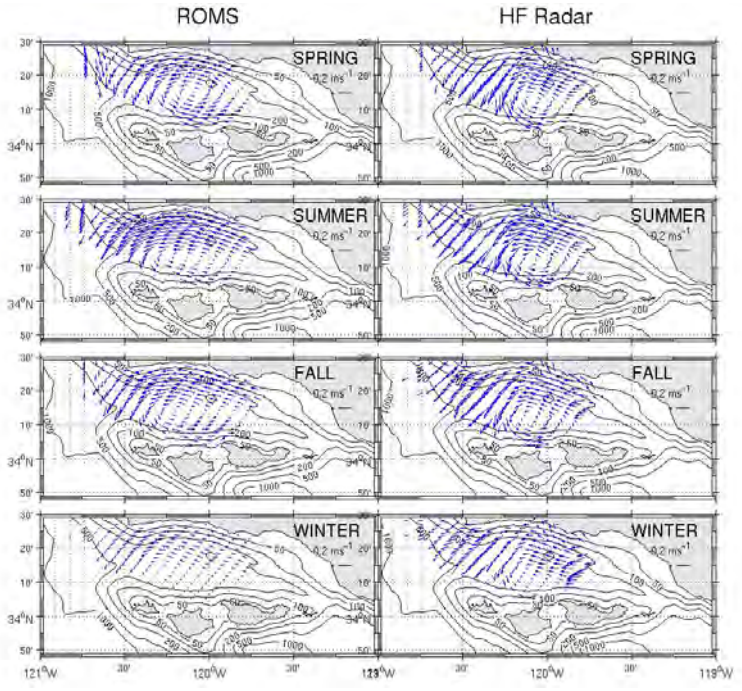
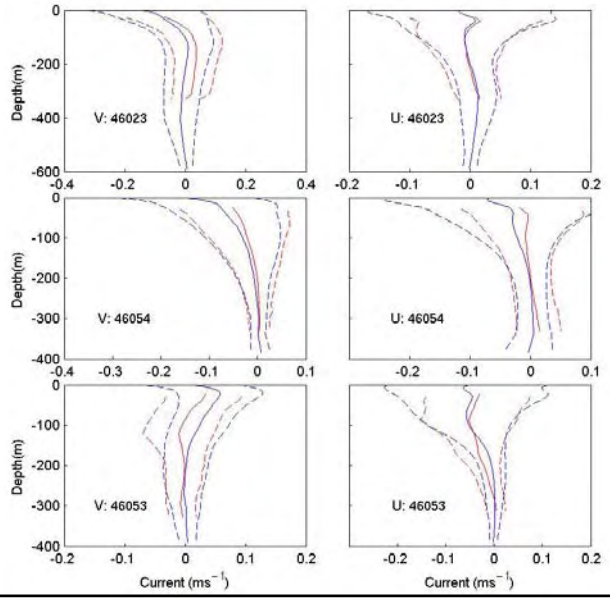


Figure 6: Mean surface currents in the SB Channel from MMS drifters (black), ROMS (blue), and MMS current meters at 5 m depth (red). The drifter means are for ensembles in gridded 10 km X 10 km bins containing more than 12 drifter tracks for each season. The current meter means are time averages at the mooring site.

Dong et al. (in review)



Comparison to ADCP Current Profiles



Profiles from SBC

Red observations
Blue model

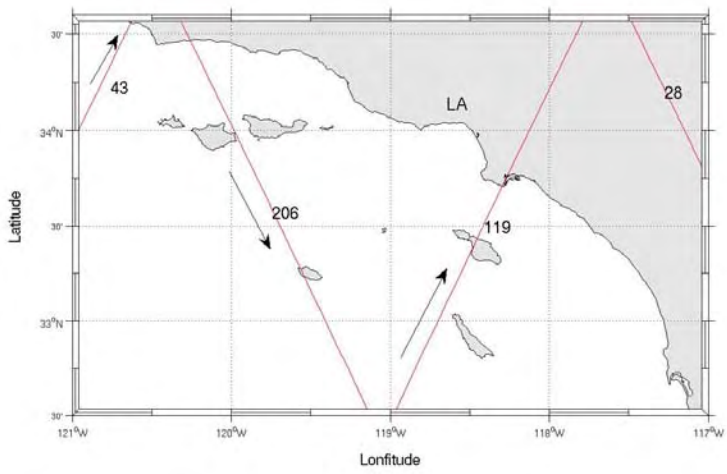
Dashes show stdev

Mean currents are well modeled

Envelope shows variability is also well modeled

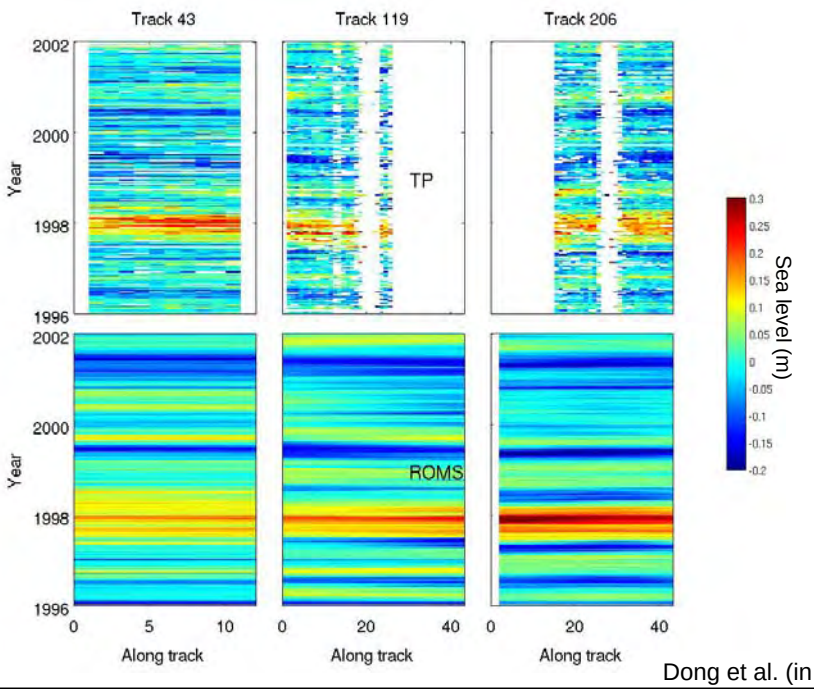
Dong et al. (in review)

Interannual Variations of Sea Level



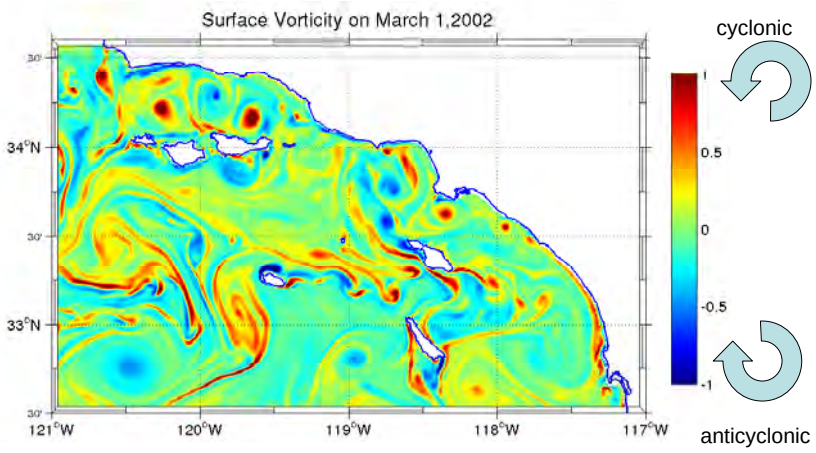
Topex/Jason - satellite sea level observations

Dong et al. (in review)



Dong et al. (in review)

Eddy Variability



Pattern is highly dynamic & contains most of the KE

Dong & McWilliams (2007)

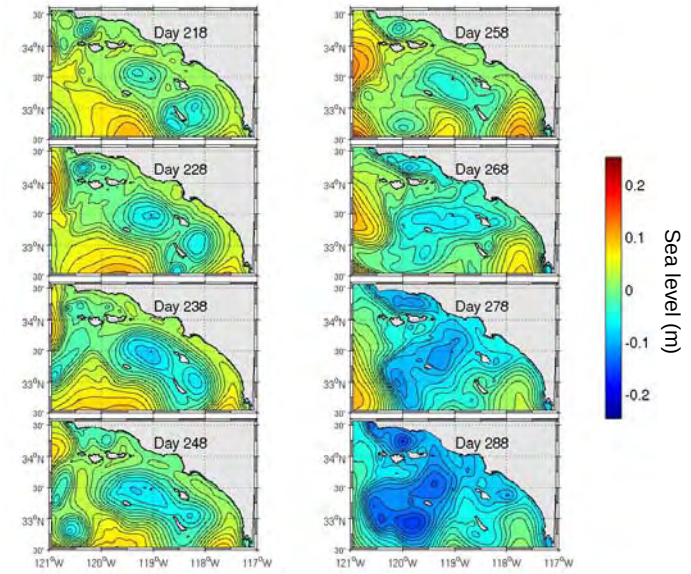


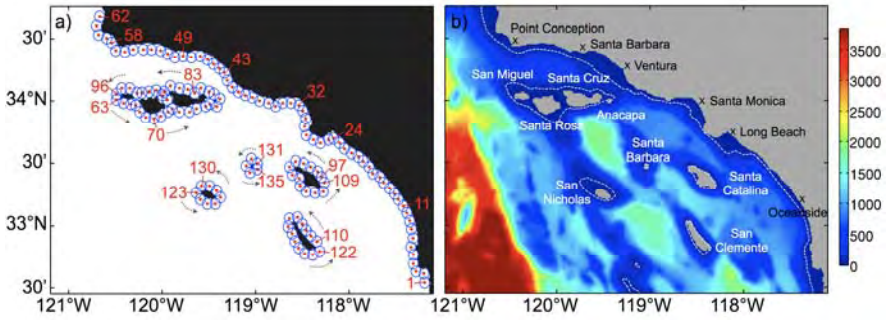
Figure 23: Evolution of SSH anomalies [m] in ROMS during the summer of 2000. Day numbers are from the start of the year, and the anomalies are relative to the year 2000 average. Three semi-permanent cyclonic eddies fluctuate and reform with time. The three eddies are separate on day 238; the Catalina-Clemente Eddy and the Central-SCB Eddy begin to merge before day 258; and then they move together offshore while two replacement eddies form behind them by day 288.

Dong et al. (in review)

Modeling of SoCal Bight Circulation

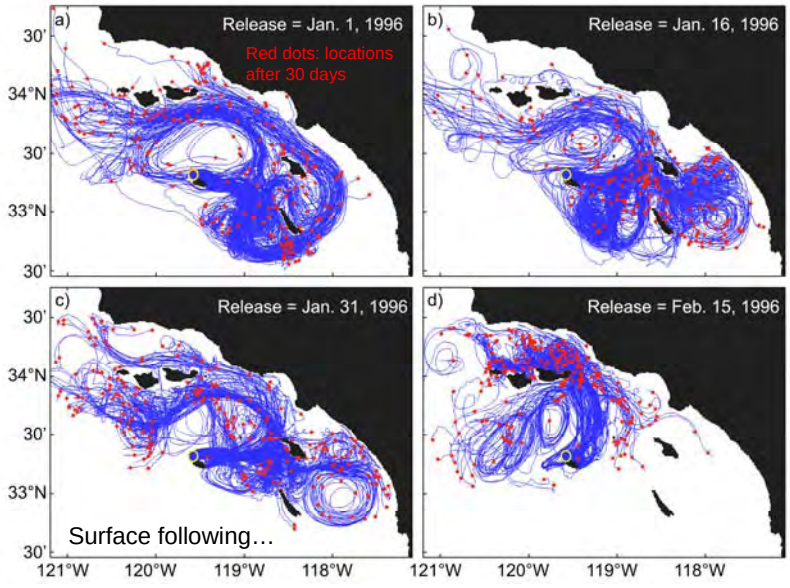
- Good fidelity of mean, seasonal & inter-annual circulation patterns
- Mean & fluctuating velocity profiles are also well modeled well
  - Currents are pretty uniform with depth
- Eddy driven circulation is large
- Can be better… but it is best available data of the circulation of the SoCal Bight

Connectivity Domain

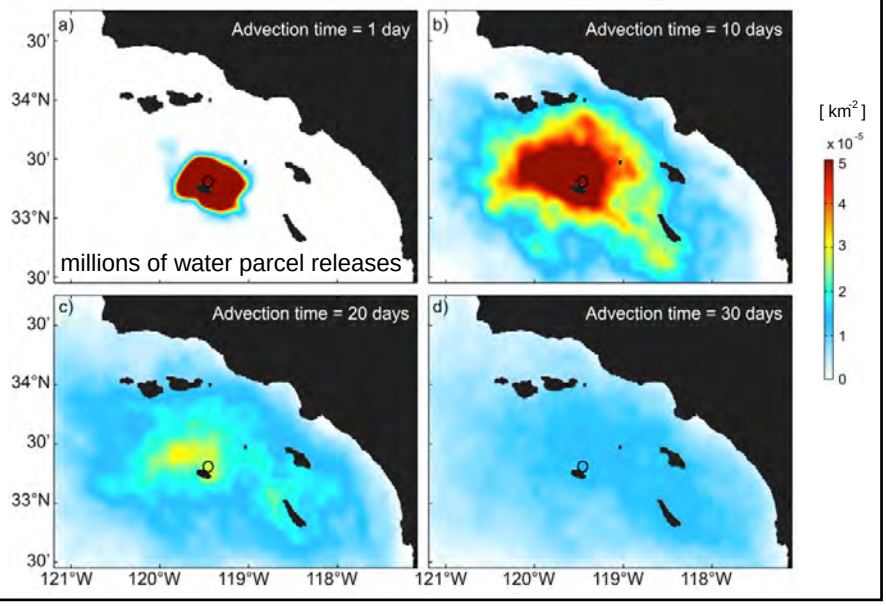


Work to follow from Mitarai et al (in review - JGR) & Watson et al (in prep)

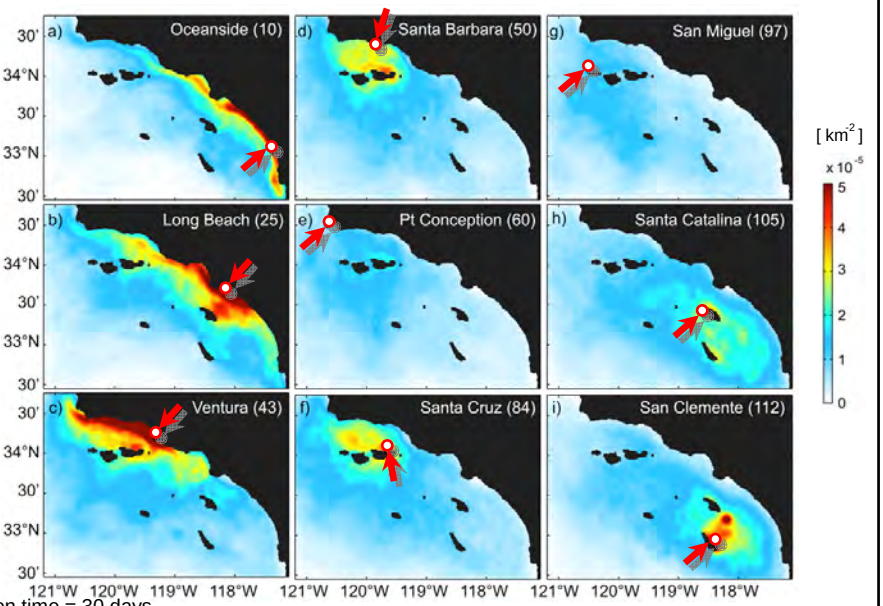
Example 30 Day Trajectories



Dispersal from San Nicolas

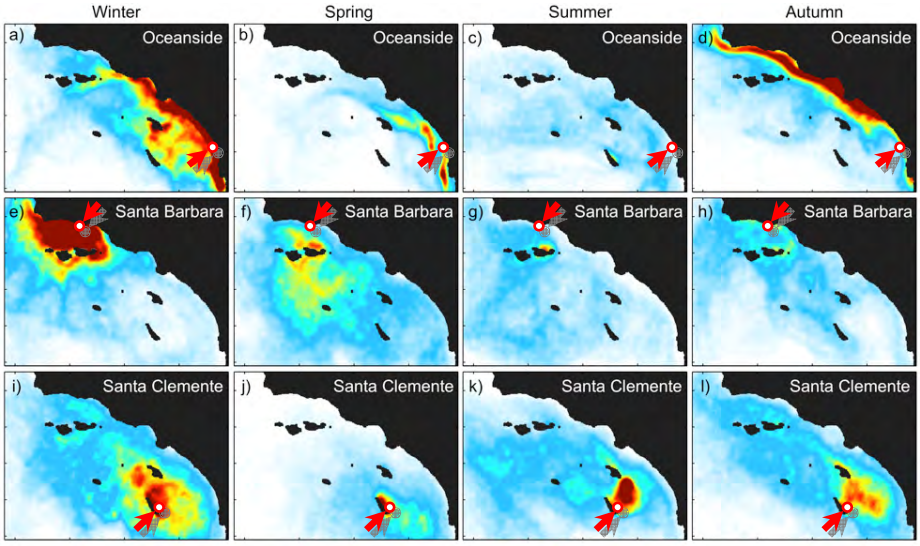


Dispersal from Other Sites



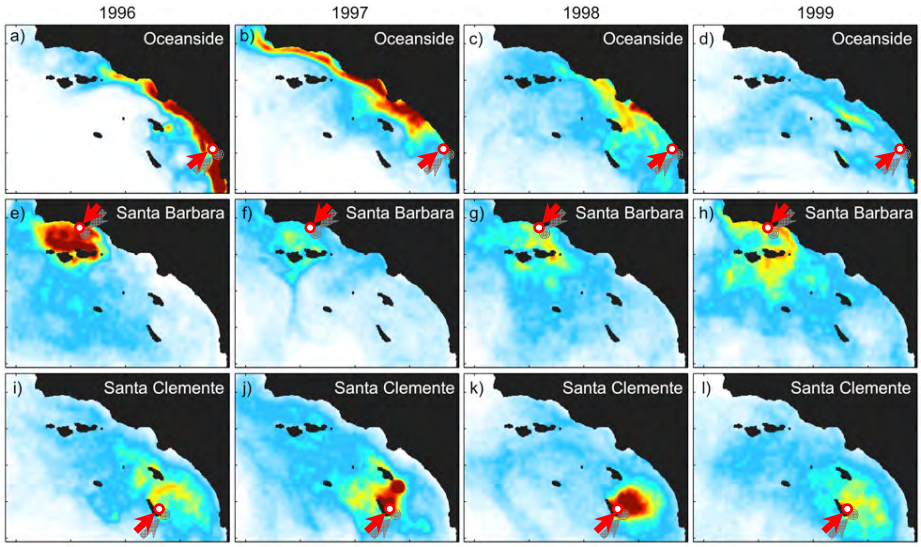
Advection time = 30 days

Seasonal Variability



Advection time = 30 days

Interannual Variability



Advection time = 30 days

Dispersal in the SoCal Bight

- Surface water parcels spread out throughout the Bight within 60 days
- Strong position-dependence

  Poleward alongshore transport from mainland

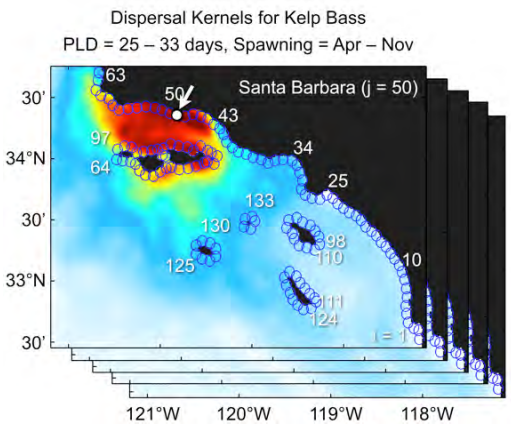
  Retention in SB Channel & around San Clemente Island
- Strong seasonal & interannual variability

Mitarai, Siegel, Watson, Dong & McWilliams (in review)

Connectivity Matrices

Larval life history is now included (PLD, spawning period, etc.)

Quantifies probability of larval transport from site to site



Repeat for all source sites

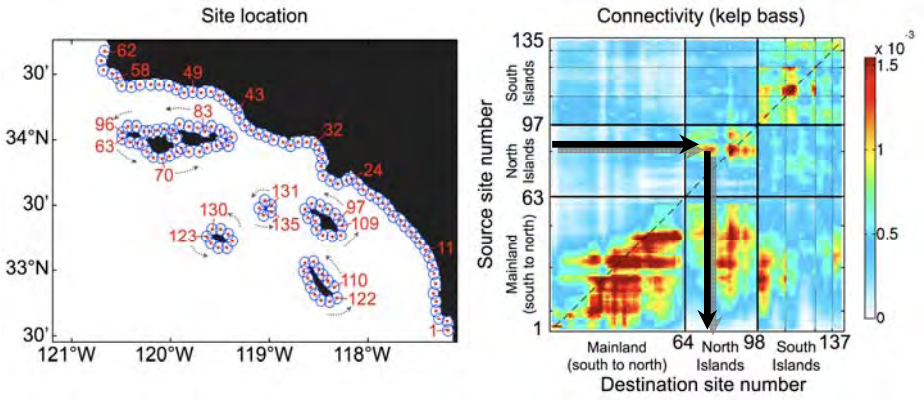
135 x 135 source-to-destination matrix (connectivity matrix)

Assumes all sites have equal larval production

potential connectivity

Watson, Mitarai, Caselle, Siegel, Dong & McWilliams (in prep)

Kelp Bass Potential Connectivity

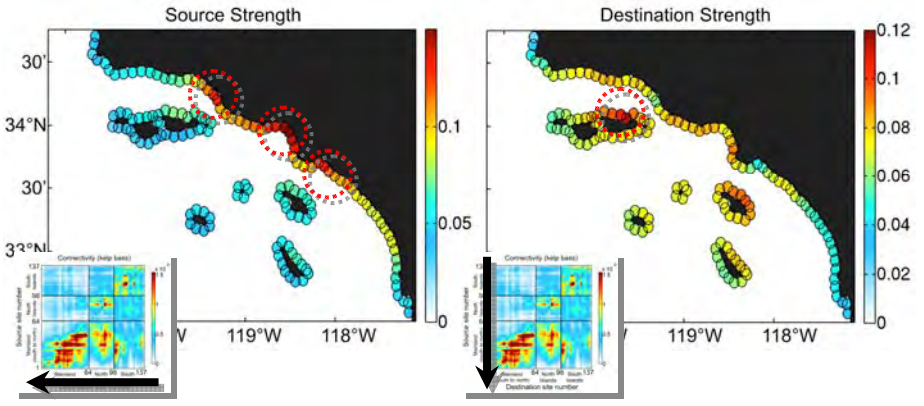


PLD = 25 – 33 d, Spawning = Apr – Nov

Connectivity is heterogeneous & asymmetric

Strong transport from mainland to islands

Kelp Bass Source / Destination Strength



Good Sources: Long Beach, Santa Monica, Ventura

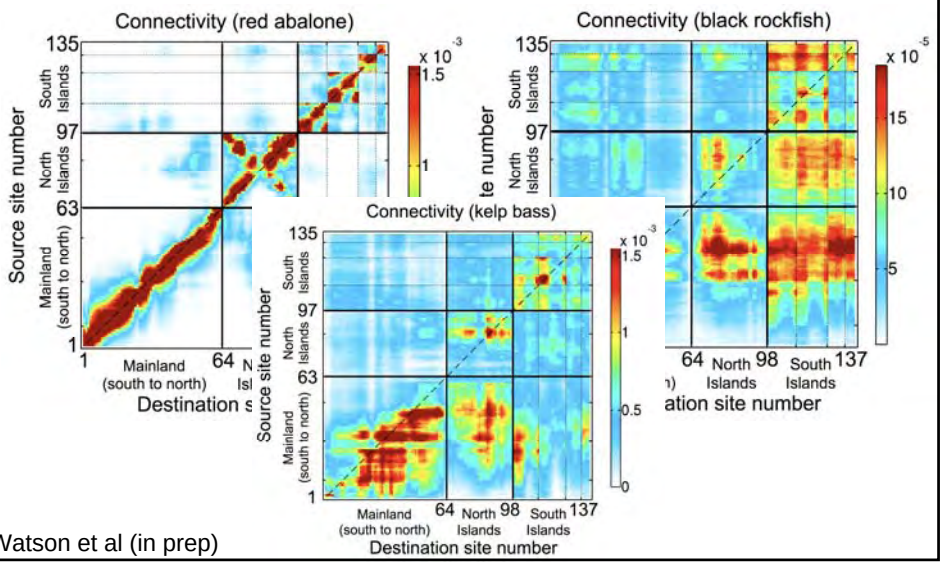
Good Destinations: Chinese Harbor, Avalon

Assumes uniform larval production PLD = 25-33 d; Spawning from Apr to Nov

The Larval Time Course Matters

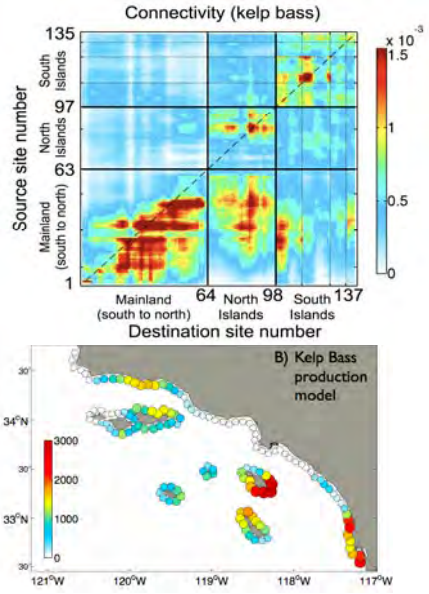
PLD = 3 – 12 days, all year around

PLD = 60 – 120 days, Jan – May

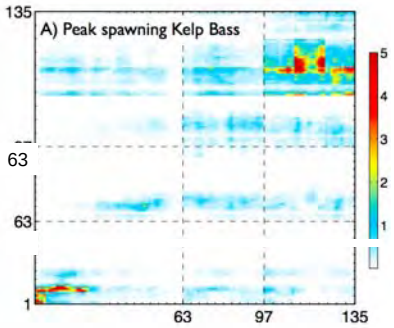


Watson et al (in prep)

Kelp Bass Realized Connectivity



- Account for non-uniform larval production
- Modeled egg production using CRANE obs



Watson et al (in prep)

Larval Connectivity in the SoCal Bight

- Mainland sites are good sources while islands are poor potential sources
- Nearby islands are often good potential destinations
- Potential connectivity patterns differ for different larval time histories
- Realized connectivity emphasizes true larval source regions